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SEMI-LONGITUDINAL STUDY OF GROWTH AND DEVELOPMENT OF CRANIO-FACIAL SOFT TISSUE OF CHILDREN AGED FROM 3 TO 11

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Today's orthodontic treatment goals lie in functional esthetics, and the importance of the latter is increasing gradually in trend. Considering such, study on growth and development of soft as well as hard tissues becomes inevitable. Early studies emphasize mainly on skeletal analysis using cephalometric data. However, more recent studies report that maxillofacial soft tissue, which plays a critical role in determining facial esthetics, is influenced by underlying hard tissue, and yet close relationship between them was not noticed.

Cephalometric x-rays were taken of 137 Korean boys and 106 girls with no systemic disease, fair developmental status and normal occlusion for two consecutive years; afterwards, soft tissue analysis, which was divided into four parts, facial form, lip position & posture, nose, and thickness, was done to correlate them with general growth.

Key words : soft tissue, growth, facial profile, lip, nose)

Two major treatment objectives in contemporary orthodontics are good function of occlusion and harmonious facial profile. Especially, emphasis on harmonious and esthetics of facial profiles is increasing. To accomplish this treatment objective it is essential to have knowledge of the development of hard and soft tissue of the craniofacial complex. There have been many reports[21,23] since the study of profile by Camper in 1794. Simon[30] was the first one who reported about changes of profile during growth and measurement of facial type in 1926. Case[8] suggested that facial outline should be considered in establishing treatment planning by observing changes before and after orthodontic treatment using facial cast. After Tweeds[35] report of the cephalometric standard based on 95 subjects in 1944, Downs[12], Riedel[27], Wylie[37] researched on skeletal analysis and esthetic facial profile using cephalometrics. These cephalometric studies, however, were mainly focused to skeletal analysis and it was dominant that soft tissue is subordinate to hard tissue.

Subtelny[33] reported that craniofacial soft tissue is influenced partly by other factors as well as underlying hard tissue in 1959. Burstone[4] stated that the thickness of soft tissue covering hard tissue is so much variable that it can hardly be correlated between soft tissue and underlying hard tissue. These studies showed large variation on soft tissue measurements and evaluating facial type only by cranio-facial skeletal structure is not sufficient and it leads to research on craniofacial structure of soft tissue. Analysis of soft tissue can be divided into two categories; study of overall facial profile and study of each components such as lip, chin, and nose. Subtelny[33,34], Elsasser and Pelton[13], Burstone[6] researched on changes of soft tissue profile according

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Distribution of subjects according to age and sex

age / sex	3	4	5	6	7	8	9	10	11	sum
boy	9	10	6	5	26	30	23	11	17	137
girl	5	7	2	5	23	17	14	8	25	106
sum	14	17	8	10	49	47	37	19	42	243

to chronologic age, Ricketts[26], Merrifield[39], Peck and Peck[23] researched on soft tissue in esthetic aspect. Vig and Cohen[36], Mamandras[17] and other researchers[2,3,10,34] researched Especially, on changes of lip. In Korea, researches on soft tissue was conducted by Kang[38], Park[41]. Lee[43] who researched on soft tissue of growing children. Choi[45] researched on changes of profiles after orthodontics treatment. Analysis of soft tissue generally, consists of three kinds of measurements; angular measurements[4,10,16,18-20,22,29,32,33], linear measurements[3,4,10,11,14,18,19,24,28,29,33], and planar measurements[19,26,31]. Angular measurements and planar measurements represent relative changes of one part from the other. Linear measurements quantify absolute amount of growth itself. The aim of this study is to establish the standards for Korean of soft tissue measurement and yearly increments of soft tissue measurements using 243 (137 male, 106 female)children aged from 3 to 11.

II. Subjects and Materials

A. Subjects

243 Subjects(137 male, 106 female) were selected from elementary and middle school students in Chunchon city, kindergarten children of D church, and preschool of Yonsei University who were aged from 3 to 11 healthy and who had a dentition of favorable growth and development pattern. Subjects were followed up for two years.

B. Method

1. X-ray taking

Cephalometric X-rays were taken at the department of radiology of Yonsei University and St. Mary hospital in Chunchon using FFD 5ft. 95Kvp, 10mA, Panex EC(Morita Co.) with intensifying screen.

2. Tracing

X-rays were traced on acetate paper and angles and lines were measured up to 0.5 degree and 0.5 mm respectively.

3. Establishing reference lines

For proper evaluation of growth and development of the soft tissue, a relatively stable reference line was established. In this study, the S-N(Sella-Nasion) line minus 7 degree was considered as the Frankfort horizontal line. Perpendicular to Frankfort is designated as pFH to measure the vertical relationship.

4. Landmarks (pic 1)

1) Glabella (G)

The most prominent point in the midsagittal plane of the forehead.

2) projected N (N′)

The point of intersection with soft tissue and line passing Nasion and parallel to FH.

3) Pronasale (Pn)

The most prominent point in the midsagittal plane of the nose.

4) Subnasale (Sn)

The point at which the nasal septum between the nostril merge with the upper cutaneous lip in the midsagittal plane.

5) Columella point (Cm)

The most anterior point of Columella of the nose.

6) Projected A point (A′)

The point of intersection with soft tissue and line passing point A and parallel to FH.

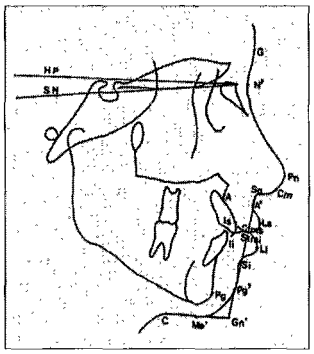
7) Stomion superius (Stms)

The most inferior point of upper lip vermilion.

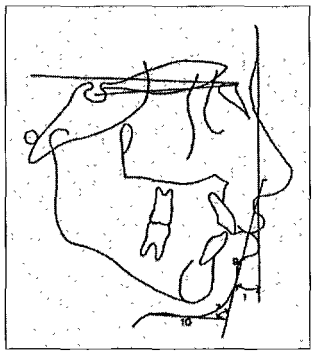
8) Incision Superius (Is)

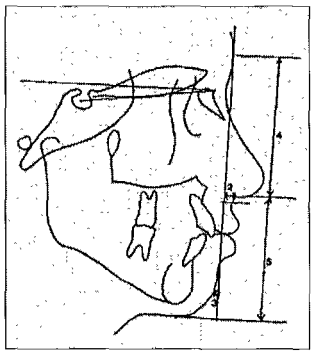
The most anterior point on maxillary incisor as determined by a tangent to the incisor passing through subspinale.

9) Incision Inferius (Ii)



pic 1. land marks


pic 2-1.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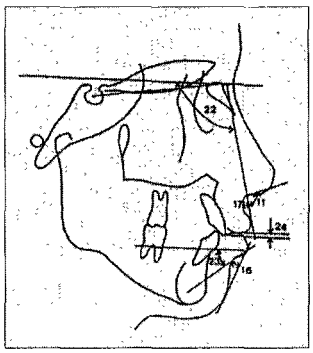
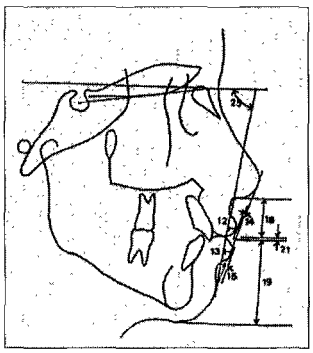

pic 3-1.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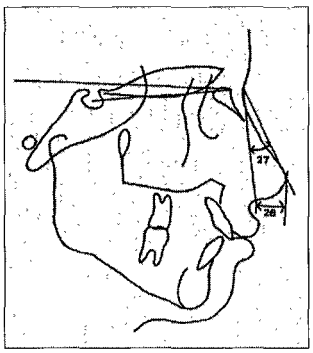
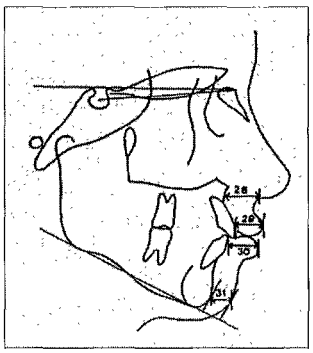

pic 4.


pic 5.

The most anterior point as measured by a line tangent to the chin and mandibular incisor.

10) Stomion Inferius(Stmi)

The most superior point of lower lip vermilion

11) Labrale inferius(Li)

The most prominent point on the lower lip as determined by a perpendicular from nasal floor

12) Mentolabial sulcus (Si)

The most concave point as measured by a line tangent to menton point and labrale inferius.

13) Pogonion (Pg)

The point on the anterior contour of mandibular symphysis tangent to mandibular plane perpendicular

14) Soft tissue pogonion (Pg')

Most anterior point on the chin as determined from a perpendicular to nasal floor.

15) Soft tissue gnathion (Gn')

The intersection of A-Pg'line and C-Me'line.

16) Soft tissue menton (Me')

Most anterior point on chin determined by a line tangent to the lower lip and the chin.

17) Cervical point (C)

The intersection between submental area and tangent line of neck.

18) Horizontal reference line (FH)

The line passing N and 7 degree subtracted from S-N line.

5. Measurements

A) Facial Form (pic 2-1,2)

1. Facial convexity angle (G-Sn-Pg')
2. Maxillary prognathism (G-Sn (FH))
3. Mandibular prognathism (G-pg'(FH))
4. Upper Facial Height (G-Sn(pFH))
5. Lower Facial Height (Sn-Me'(pFH))
6. Vertical Height Ratio ((G-Sn/Sn-Me') X 100%)
7. Lower face-throat angle (Sn-Gn'-C)
8. Lower vertical height-depth ratio (Sn-Gn'/C-Gn')
9. Lower vertical height (Sn-Gn')

10. Lower throat depth (C-Gn')

B) Lip Position and Form (pic 3-1,2)

11. Nasolabial angle (Cm-Sn-Ls)
12. Upper lip protrusion (Ls-(Sn-Pg'))
13. Lower lip protrusion (Li-(Sn-Pg'))
14. Perpendicular distance from Pn-Pg' line to Ls (Ls-(Pn-Pg'))
15. Perpendicular distance from Pn-Pg' line to Li (Li-(Pn-Pg'))
16. Mentolabial sulcus (Si-(Li-Pg'))
17. Perpendicular distance from A' and Sn-Ls line (A'-(Sn-Ls))
18. Upper lip length (Sn-Stms(pFH))
19. Chin length (Stmi-Me'(pFH))
20. Vertical lip-chin Ratio ((Sn-Stms/Stmi-Me') X 100%)
21. Interlabial gap (Stms-Stmi)
22. Upper lip angle to FH (Sn-Ls (deg to FH))
23. Lower lip angle to FH(Li-Si (deg to FH))
24. Maxillary incisor exposure (Stms-Is(pFH))
25. Angle to FH of lower face (Sn-Pg' (deg to FH))

C) Nose (pic 4)

26. Prominency of nose (Pn-Sn (FH))
27. Inclination of the nose (Sn-N'-Pn)

D) Thickness (pic 5)

28. Distance between A and Sn parallel to FH (A-Sn (FH))
29. Upper lip thickness (Is-Ls (FH))
30. Lower lip thickness (Ii-Li (FH))
31. Chin thickness (Pg-Pg'(FH))

Ⅲ. RESULTS

1. Facial Form

In boys, facial convexity, G-Sn-Pg'(deg) increased according to age and total of 5 degrees increased during the observation period. Sn-Gn'-C(deg) which could be used to evaluate relative prominency of the chin did not change radically through out the observation period, while absolute length continued to grow such as G-Sn(FH), G-Sn(pFH), G-Pg'(FH), Sn-Me'(pFH), Sn-Gn', C-Gn'. The ratio between upper face and lower face, G-Sn/Sn-Me', showed a decreasing

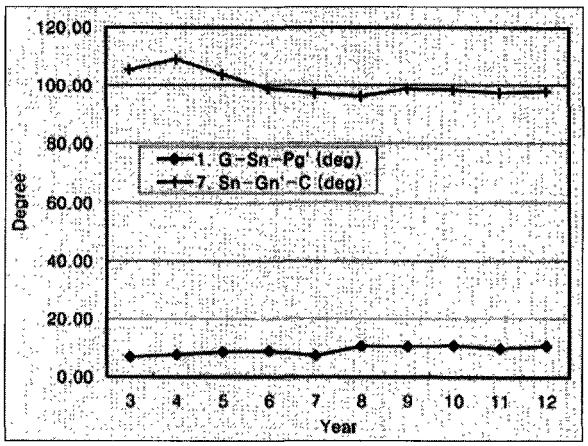


Fig. 1. Change of facial profile in boys(degree)

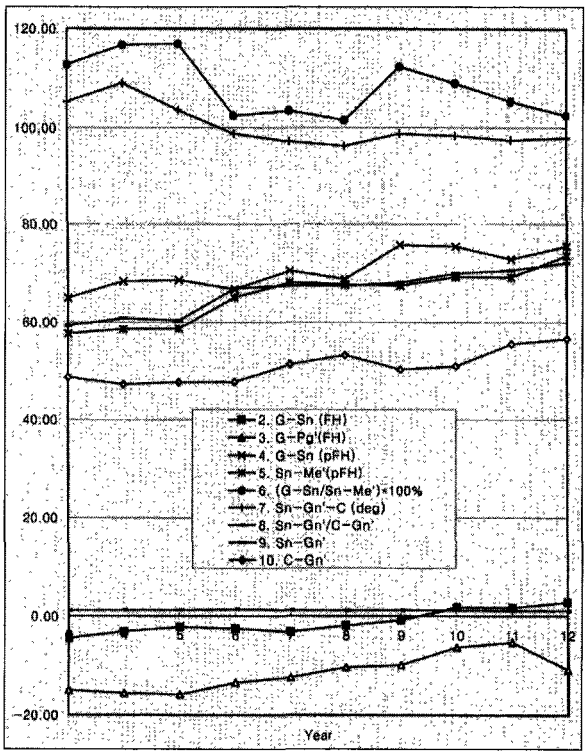


Fig. 2. Change of facial form in boys (length)

tendency.(table 1 Facial form, fig 1)

In general, girls showed litlle difference from boys, especially facial convexity did not change (table 1 Facial form, fig 3,4).

2. Lip Position and Form

Boys, showed no nasolabial angle change, while one

Table 1. Facial form

MALE

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
1. G-Sn-Pg'(deg)	6.89	7.71	8.67	8.91	7.43	10.69	10.66	10.92	9.90	10.81
	3.17	3.28	2.19	4.95	3.89	3.59	3.59	5.69	5.62	6.83
2. G-Sn(FH)	-4.33	-3.04	-2.14	-2.47	-3.08	-1.77	-1.77	1.92	1.85	3.00
	4.06	4.00	1.88	3.72	3.39	4.94	494	3.23	4.07	2.59
3. G-Pg'(FH)	-15.00	-15.59	-15.92	-13.50	-12.38	-10.27	-10.27	-6.08	-5.08	-10.71
	6.09	5.63	4.69	5.78	8.92	9.61	9.61	8.88	9.63	10.23
4. G-Sn(pFH)	65.00	68.36	68.58	66.75	70.55	68.79	68.79	75.58	72.98	75.67
	6.60	5.71	6.52	3.81	4.99	9.44	9.44	5.03	11.07	5.46
5. Sn-Me'(pFH)	57.67	58.59	58.67	65.13	68.14	67.72	67.72	69.30	6926	73.73
	5.45	3.14	4.42	4.18	4.77	6.28	6.28	4.76	5.83	5.82
6. (G-Sn/Sn-Me')*100%	112.72	11668	116.90	102.50	103.53	101.58	101.58	109.06	105.36	102.62
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7. Sn-Gn'-C(deg)	105.28	109.04	103.58	98.884	97.28	96.36	96.36	98.47	97.58	98.07
	7.22	8.73	4.85	7.31	8.85	19.00	19.00	6.17	9.25	8.66
8. Sn-Gn'/C-Gn'	1.22	1.29	1.27	1.40	1.32	1.27	1.27	1.37	1.27	1.27
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9. Sn-Gn'	59.33	60.83	60.40	66.89	67.53	67.50	67.50	70.00	70.70	72.25
	3.33	4.08	3.07	3.96	4.95	3.94	3.94	0.00	9.23	6.52
10. C-Gn'	48.67	47.17	47.60	47.68	51.29	53.25	50.29	51.00	55.60	56.71
	5.52	3.89	4.03	4.92	7.14	5.14	7.72	0.00	6.84	8.73

FEMALE

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
1. G-Sn-Pg'(deg)	7.00	9.69	13.40	12.13	10.09	12.50	9.13	12.00	12.15	14.04
	1.52	4.12	4.12	4.45	4.71	5.69	3.35	3.46	4.47	15.81
2. G-Sn(FH)	-6.10	-4.44	-4.44	-1.00	-3.50	-1.81	-0.20	2.65	2.88	2.13
	1.69	5.36	5.36	3.34	4.00	3.47	4.06	2.38	4.95	4.80
3. G-Pg'(FH)	-19.30	-16.75	-16.75	-16.50	-16.59	-10.67	-10.33	-10.00	-10.08	-9.40
	4.64	8.12	8.12	3.70	7.00	6.65	7.57	7.39	6.32	7.94
4. G-Sn(pFH)	66.80	66.00	66.00	67.96	70.22	70.92	74.88	77.79	76.00	74.29
	2.32	3.70	4.42	4.45	4.77	4.72	4.55	4.28	5.04	7.70
5. Sn-Me'(pFH)	57.80	50.15	59.33	62.00	65.19	67.23	64.67	68.04	70.30	71.29
	3.66	7.90	2.56	3.00	3.81	3.91	3.12	4.51	4.62	3.72
6. (G-Sn/Sn-Me')*100%	115.57	114.61	111.38	109.62	107.72	105.49	115.79	114.33	108.11	104.21
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7. Sn-Gn'-C(deg)	104.80	106.88	99.08	100.54	90.21	96.85	97.29	101.21	100.17	97.23
	7.55	9.66	3.49	5.78	7.01	6.80	9.33	4.16	8.16	9.90
8. Sn-Gn'/C-Gn'	1.27	1.35	1.36	1.40	1.47	1.41	1.36	1.31	1.31	1.34
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9. Sn-Gn'	61.60	62.00	60.80	64.69	67.88	69.00	66.59	68.00	71.92	72.00
	4.32	4.34	2.48	3.29	3.95	3.97	3.43	3.50	5.20	4.34
10. C-Gn'	48.60	46.00	44.60	46.35	46.25	53.90	49.09	52.00	54.83	53.85
	4.76	3.46	6.15	6.63	5.54	3.69	5.41	7.70	6.35	8.55

Table 2-1. Lip position and form (male)

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
11. Cm-Sn-Ls(deg)	95.55	93.71	92.92	92.00	91.50	91.89	92.09	95.12	96.14	92.84
	10.08	11.38	10.79	14.23	9.25	9.46	8.37	12.10	14.04	14.51
12. Ls(Sn-Pg')(L)	8.94	8.33	8.17	7.89	7.36	7.58	7.77	7.90	7.88	8.81
	1.30	1.55	1.07	1.69	2.12	1.95	1.55	1.82	2.22	2.34
13. Li-(Sn-Pg')(L)	5.61	5.96	5.67	5.09	5.38	6.37	6.64	6.75	6.74	6.78
	1.74	1.05	1.40	1.83	1.93	2.42	1.84	1.71	2.50	2.53
14. Ls-(Pn-Pg')(L)	4.06	4.13	3.33	3.00	2.88	2.79	2.09	2.48	2.02	2.44
	1.52	2.20	1.25	2.00	2.63	2.17	1.87	1.69	1.92	1.98
15. Li-(Pn-Pg')(L)	2.56	3.04	2.58	2.31	2.68	2.80	3.63	3.48	3.76	3.10
	1.66	1.23	1.37	2.11	2.28	2.62	1.97	1.55	2.50	2.74
16. Si(Li-Pg')(L)	4.83	4.83	4.25	4.75	4.60	4.23	4.45	4.73	5.05	5.44
	0.75	1.14	0.38	1.05	0.93	1.35	1.14	1.13	1.16	1.09
17. A'(Sn-Ls)(L)	1.44	1.14	1.58	2.06	1.19	1.40	1.36	1.54	1.17	1.28
	0.77	0.64	0.34	2.23	0.53	0.65	0.45	0.54	0.67	0.53
18 Sn-Stms(pFH)	19.01	20.54	20.17	20.94	22.24	21.96	22.55	24.02	23.67	23.11
	2.01	2.38	1.86	2.08	3.10	2.64	3.30	2.62	1.94	3.50
19. Stmi-Me'(pFH)	35.78	37.67	38.00	43.81	45.48	45.42	44.59	46.01	46.74	47.33
	2.21	3.02	4.20	3.07	4.12	5.12	3.64	5.02	5.54	6.89
20.(Sn-S tms/Stmi-Me')*100%	53.13	54.54	53.07	47.79	48.90	48.35	50.58	48.21	47.11	48.82
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.16	0.00
21.Stms-Stmi(pFH)	3.50	3.50	3.00	1.20	2.25	2.50	1.67	2.67	2.50	1.00
	2.00	0.50	0.00	0.40	1.64	1.12	0.94	2.09	2.06	0.00
22. Sn-Ls(deg To FHH)	116.39	105.54	113.67	109.84	105.67	109.85	111.57	110.73	110.51	110.37
	3.78	29.18	10.53	10.13	22.04	8.48	6.61	9.66	10.50	11.67
23. Li-Si(deg To FHH)	29.17	30.63	30.17	37.59	37.95	36.80	31.04	32.35	31.21	33.75
	9.06	12.50	5.64	6.64	12.12	9.57	10.44	9.58	11.57	11.97
24. Stms-ls(pFH)	0.00	1.50	3.67	2.87	2.61	3.22	2.65	2.42	2.03	2.29
	0.00	0.00	1.89	1.66	1.89	1.98	1.86	1.37	1.37	0.96
25. sn-Pg'(deg to FH)	78.06	76.79	77.50	78.72	79.79	80.77	80.18	78.13	80.62	80.54
	3.53	3.36	3.99	4.32	4.80	8.22	4.50	12.16	5.70	6.84

Table 2-2. Lip position and form (female)

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
11. Cm-Sn-Ls(deg)	103.80	96.06	99.83	99.12	95.06	92.04	99.08	98.14	96.90	95.52
	7.70	10.72	6.22	8.99	9.01	10.34	8.96	9.07	11.95	11.06
12. Ls(Sn-Pg')(L)	7.40	6.81	6.08	7.69	7.47	7.31	6.00	6.25	6.95	7.25
	1.02	1.68	1.69	1.56	1.39	1.51	1.41	1.84	1.89	1.27
13. Li-(Sn-Pg')(L)	4.90	5.06	4.75	5.35	5.47	5.58	5.25	5.29	5.83	6.19
	0.66	1.18	1.03	1.34	1.28	1.74	1.05	1.70	1.77	1.88
14. Ls-(Pn-Pg')(L)	3.40	1.94	2.30	3.62	2.20	1.25	1.50	1.60	1.12	1.31
	1.20	1.47	1.94	1.82	1.81	1.57	1.28	2.32	2.94	1.96
15. Li-(Pn-Pg')(L)	2.20	2.29	2.40	3.08	2.03	2.14	2.00	1.75	2.71	2.75
	1.17	1.03	1.50	1.63	1.45	1.38	1.02	2.40	1.93	2.08
16. Si(Li-Pg')(L)	3.60	4.44	3.17	3.31	3.69	3.62	3.75	4.32	4.42	4.21
	0.97	1.16	0.94	0.82	1.39	0.96	1.03	0.88	0.92	0.93
17. A'(Sn-Ls)(L)	0.90	1.31	0.92	1.58	1.47	1.08	1.09	1.39	1.55	1.33
	0.26	0.56	0.53	0.53	0.62	0.38	0.36	0.43	0.71	0.43
18 Sn-Stms(pFH)	24.80	18.03	19.17	21.00	20.36	21.08	21.42	22.36	22.35	22.96
	10.17	7.09	1.67	1.41	5.41	1.54	1.85	2.16	5.55	1.74
19. Stmi-Me'(pFH)	36.50	33.59	39.50	40.54	43.00	46.00	43.00	44.82	4610	47.96
	2.87	2.47	3.10	3.75	3.66	3.59	2.27	3.91	4.67	3.13
20.(Sn-S tms/Stmi-Me')*100%	67.95	53.67	48.52	51.80	47.35	45.82	49.81	49.88	48.48	47.87
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21.Stms-Stmi(pFH)	1.00	1.00	2.00	2.67	1.86	1.00	3.33	0.69	2.50	1.60
	0.00	0.00	0.00	1.25	2.10	0.00	2.62	0.00	2.06	0.80
22. Sn-Ls(deg To FHH)	101.40	110.75	111.67	111.58	102.75	112.77	107.63	106.64	107.88	107.73
	10.82	7.16	9.39	6.94	27.46	7.25	8.63	8.29	7.69	16.24
23. Li-Si(deg To FHH)	29.20	26.63	40.25	37.00	37.53	41.46	34.83	37.89	33.75	37.13
	13.47	6.66	12.36	8.60	9.47	7.99	10.61	9.15	9.59	9.49
24. Stms-ls(pFH)	2.30	2.50	2.40	3.14	2.13	3.58	2.92	2.00	2.79	2.87
	0.00	0.71	1.98	3.18	3.71	1.96	1.29	1.58	2.69	1.29
25. sn-Pg'(deg to FH)	63.80	76.31	77.67	84.92	76.63	74.82	79.75	79.61	78.68	80.67
	25.94	4.22	4.14	27.41	4.65	19.54	3.98	3.44	3.26	4.38

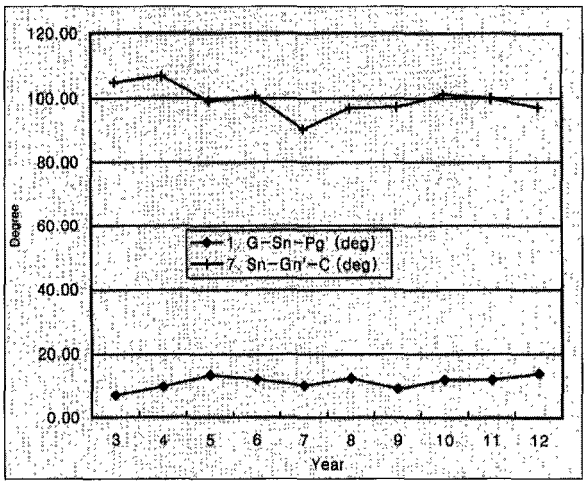


Fig. 3. Change of facial profile in girls (degree)

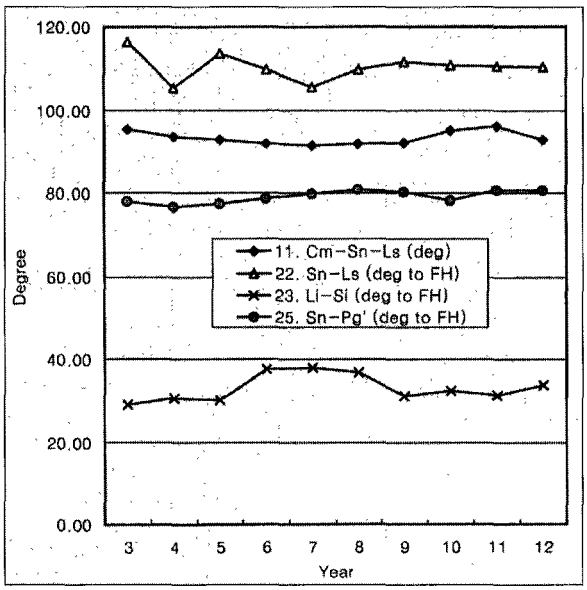


Fig. 5. Change of lip position and form in boys(degree)

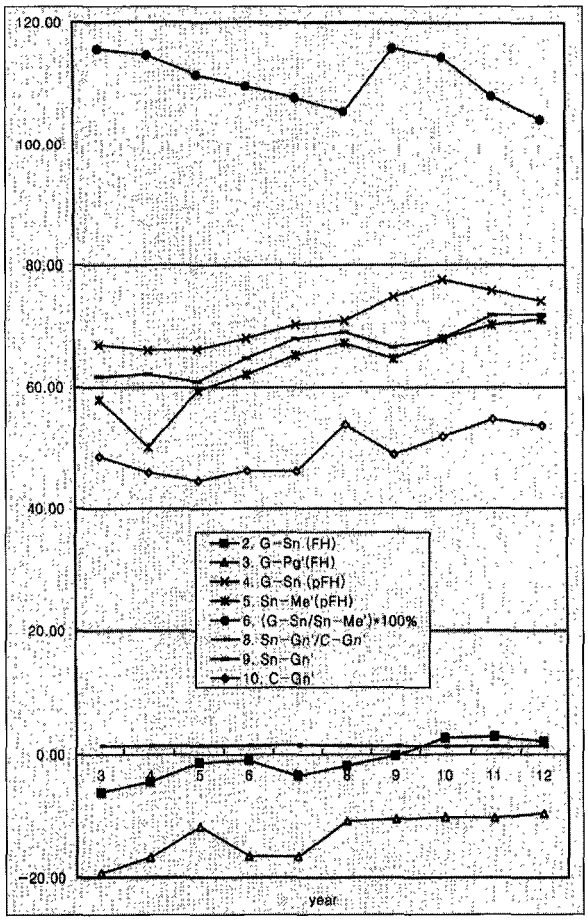


Fig. 4. Change of facial profile in girls (degree)

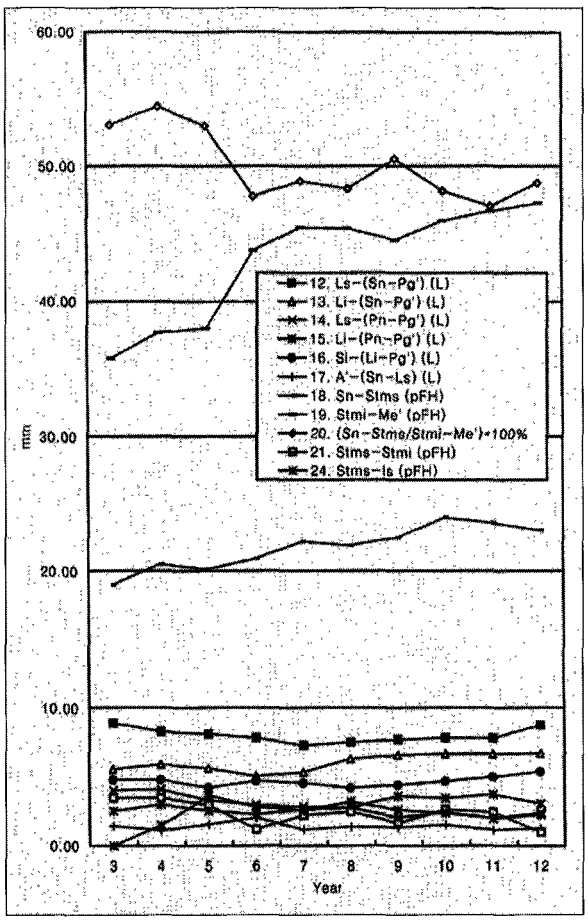


Fig. 6. Change of lip position and form in boys (length)

Table 3. Nose

MALE

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
26. Pn-Sn(FH)	9.56	9.50	9.58	10.53	11.57	11.70	11.88	12.00	12.29	12.43
	0.96	1.32	0.73	1.26	1.47	1.90	1.16	6.26	1.78	2.77
27. Sn-N'-Pn(deg)	18.44	1863	16.75	17.47	18.05	17.98	17.71	17.40	17.55	17.60
	1.32	3.60	0.85	1.42	2.05	1.88	1.80	1.91	2.57	2.05

FEMALE

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
26. Pn-Sn(FH)	1050	10.56	10.80	10.35	11.50	11.00	10.92	11.00	12.95	12.15
	4.35	1.01	1.37	1.66	1.39	2.86	2.83	9.07	1.63	2.19
27. Sn-N'-Pn(deg)	16.70	18.06	17.00	16.19	17.47	18.50	18.00	18.07	17.83	18.71
	3.17	1.81	6.28	2.54	1.65	1.49	1.51	1.13	1.54	2.01

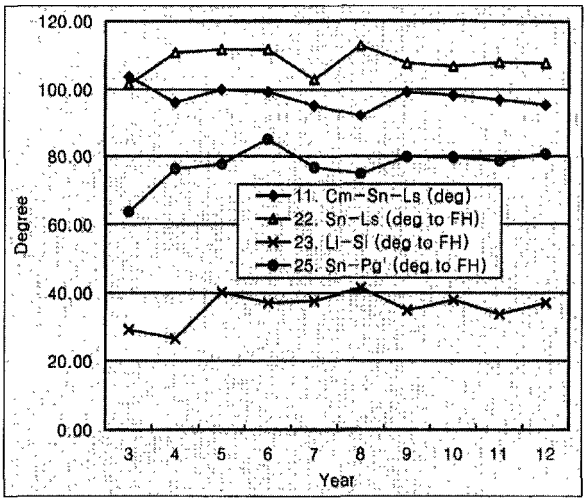


Fig. 7. Change of lip position and form in girls (degree)

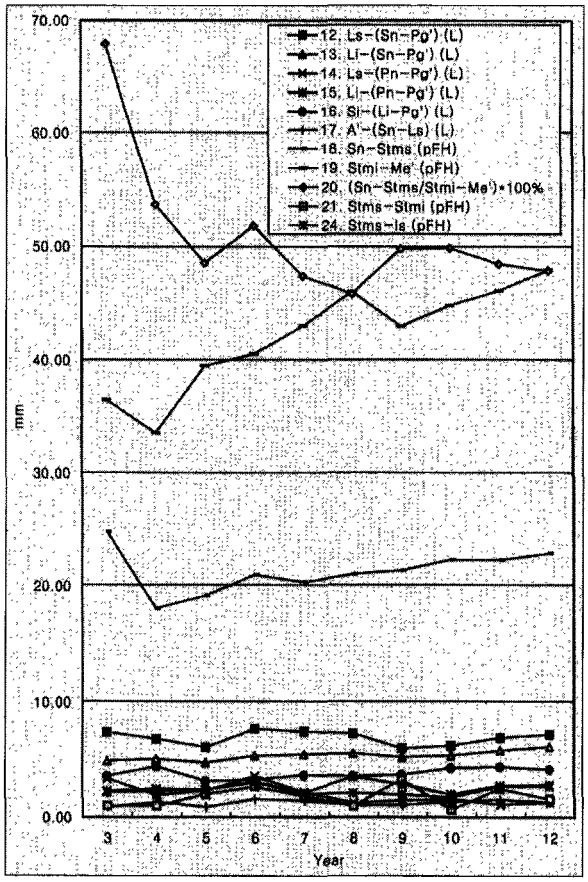


Fig. 8. Change of lip position and form in girls (length)

third of lower facial height, Stmi-Me'(pFH), increased. Upper lip length, Sn-Stms(pFH), increased a little but not significantly. The vertical relationship between upper lip and lower lip Sn-Stms/Stmi-Me decreased in some degree. Ls-(Sn-Pg'), Li-(Sn-Pg'), Ls-(Pn-Pg'), Li-(Pn-Pg') which indicate thickness of the lip did notchange. The depth of mentolabial sulcus (Si-(Li-Pg')) increased, and A'-(Sn-Ls) increased as well. Sn-Ls (deg to FH), Li-Si(deg to FH), Sn-Pg'(deg to FH) which show relative position of lip to the cranium did not change(table 2-1 lip position and form, fig 5,6).

Girls showed similar tendency with that of boys (table2-2 lip position and form, fig 7,8)

Table 4. Thickness

MALE

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
28. A-Sn(FH)	9.56	10.25	10.08	10.59	11.14	12.06	12.29	12.73	13.45	14.97
	1.36	1.09	2.19	1.05	1.28	1.30	1.48	1.46	1.60	2.16
29. Is-Ls(FH)	14.44	14.58	13.75	13.88	13.29	13.17	15.20	14.50	13.29	14.67
	1.83	2.18	1.46	1.74	1.81	1.82	1.52	21.04	1.82	1.99
30 Ii-LI(FH)	13.00	12.63	12.67	13.38	11.98	12.67	12.88	12.85	13.64	14.13
	1.60	1.50	1.52	1.68	1.37	1.68	1.53	1.26	1.90	1.58
31 Pg-Pg'	11.17	11.17	11.50	11.75	12.31	12.63	12.10	12.94	12.74	12.93
	2.01	1.66	1.54	2.30	2.86	2.63	2.08	2.68	2.73	2.67

FEMALE

MEASUREMENT	3	4	5	6	7	8	9	10	11	12
28. A-Sn(FH)	9.50	9.88	10.42	10.62	11.09	11.00	11.71	13.14	14.03	13.75
	1.58	0.82	1.42	1.21	0.96	1.09	1.36	1.17	1.67	1.84
29. Is-Ls(FH)	13.30	12.94	12.08	13.50	13.25	12.27	11.25	12.00	13.15	12.90
	0.68	1.42	1.64	1.64	1.94	1.90	1.70	1.86	2.03	1.92
30 Ii-LI(FH)	10.70	12.25	13.08	11.96	11.81	12.31	11.63	12.57	12.80	13.15
	1.40	2.05	1.37	0.84	1.20	1.25	1.12	1.24	2.03	1.85
31 Pg-Pg'	10.88	11.06	11.0	11.00	10.91	11.23	10.08	11.54	13.18	12.94
	2.13	1.99	1.87	1.62	2.17	2.14	2.01	3.01	2.70	2.10

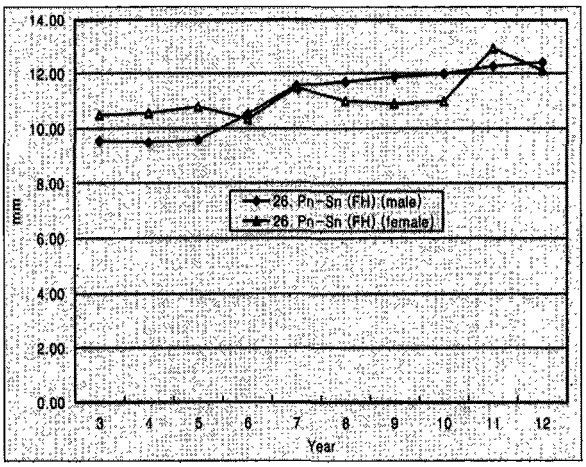


Fig. 9. Change of lip thickness in boys(lengh)

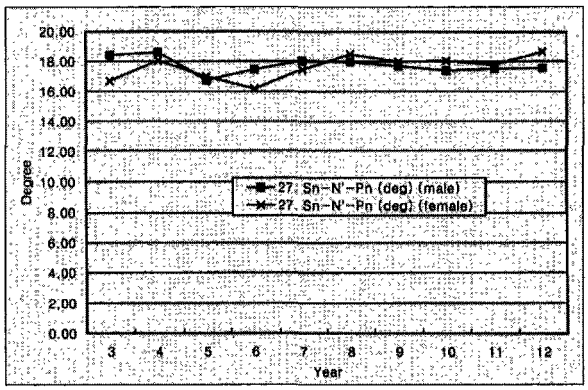


Fig. 10. Change of lip thickness in girls(degree)

3. Nose

In boys, Pn-Sn(FH) which indicates absolute height of nose increased with age while Sn-N'-Pn(deg) which indicates prominency of nose did not change. (table 3 Nose, fig 9,10)

Similar results was observed in girls.(table3 Nose, fig 9,10)

4. Thickness

In boys, the thickness of upper lip near the base of

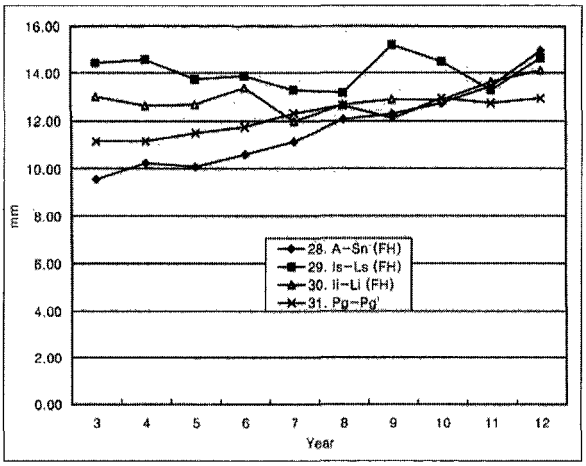


Fig. 11. Change of lip thickness in boys

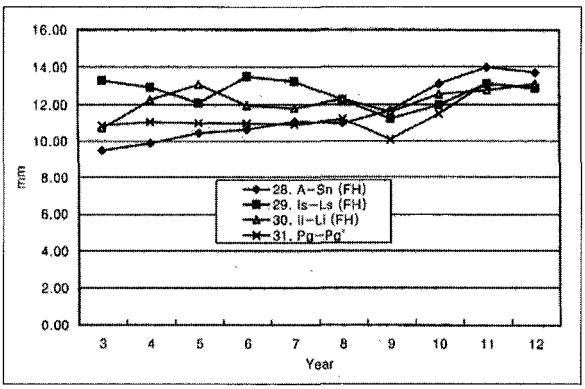


Fig. 12. Change of lip thickness in girls

nose(A-Sn(FH) showed marked increase according to age, Is-Ls(FM), Ii-Li(pFH), Pg-Pg' which are thickness of upper lip, lower lip and thickness of chin respectively increased as well. (table4 Thickness, fig 11)

In girls, increment of A-Sn(FH)was less than that of boys, and Is-Ls(FH) changed with very small amount. But Ii-Li(FH)와 Pg-Pg' changed with age (table4 Thickness, fig 12)

Ⅳ. Discussion

1. Facial Form

Bishara, Hession, Peterson[2] reported that facial convexity of child increase with age from 5-17 , average 169.73 degree at 5 years of age and 171.28 degree at 17 years of age. In the longitudinal study of Subtelny[33], O Mauchamp[18], Chaconas[10], facial convexity remains constant after 6 years of age. Especially O Mauchamp[18] stated that facial convexity has no correlation with facial type and chronologic age. Lee[43] reported that 10.3 years old mixed dentition children showed 169.02 and 169.27 degree in Korean boys and girls respectively. Burstone[4] reported 11.3 degree in 40 samples in caucasian children. The result of this study opposes to that of Bishara's in that facial convexity increases a little in boys due to different measurement technique. It is considered to be related with the fact that increment of A-Sn of boys are greater than that of girls(table 4 Thickness) and typical downward and forward growth of Pog' occur after 12 years of age. As the sample shows normal growth and development, Sn- Gn'-C remains unchanged according to age. G-Sn(FH), G-Sn (pFH), G-Pg'(FH), Sn-Me'(pFH), Sn-Gn', C-Gn' showed increment proportional to that of cranium because those measurements are absolute linear measurements. G-Sn/Sn-Me' increased with age and it could be postulated that lower structure grows faster than that of superior structure.

2. Lip Position and Form

Nasolabial angle (Cm-Sn-Ls) did not change according to age but the mean value 93.11 degree and 97.56 degree for boys and girls were smaller than Burstone's[7] caucasian mean 102 degree. More acute angles were observed in boys than girls. Kim[39] reported that this angle decrease with age from 6-8 years of age with 15 sample and at the age of 16 the mean value for boys and girls were 99.56±6.75, 97.27±7.00 degree. Chung[44]reported in his soft tissue longitudinal study that Ls-(Pn-Pg') was greater in girls at age 6 but at age of 13 it reverses. Li-(Pn-Pg') was similar in boys and girls at age 6 but greater in boys at age 13 due to difference of chin prominency. Kim, Yoo[40] reported that Ls-(Pn-Pg') and Li-(Pn-Pg')did not change according to age in their study with 90 subject of 6-10 years of children and it showed no statistical difference between the groups divided by Sn-MP angle. Park[42]found no

correlation between Li-(Pn-Pg′) and age in his 4 year longitudinal study. Bishara et al[2] stated that Li-(Pn-Pg′)increase with age especially at 13-14 years with great increment in his longitudinal study from 5 years to adult sample. In this study, the average value of Ls-(Pn-Pg′)and Li-(Pn-Pg′) for boys and girls generally did not change and the measurement excludes growth of nose, Ls-(Sn-Pg′)and Li-(Sn-Pg′)did not changed as well. Average values in boys and girls were 8, 6.1, and 6.9, 5.4 respectively. This finding showed greater value than Burstone's Ls-(Sn-Pg′) 3.5mm and Li-(Sn-Pg′) 2.2mm[6] due to ethnic difference and girls showed more prominent lips. The measurement of mental sulcus Si-(Li-Pg′)increased according to age in both boys and girls. It could be considered that region of sulcus grow less than other part but actually it is due to continued growth of chin area. Sulcus depth of upper lip A′-(Sn-Ls) also increased in both boys and girls but its amount was less than mental sulcus. Lower lip length and lower one third of face, Stmi-Me′(pFH) increased with age while upper lip length Sn-Stms(pFH) grew very little. As a result, Sn-Stms/Stmi-Me′ decreased continuously. This seems to be related in that lower structure of the cranio-facial complex grows more than that of upper one. Kim[39] used Sn-Stms, Stmi-B′(projected B) to evaluate the vertical length of upper and lower lip and reported that it grew with age in both boys and girls while there were no statistical difference between upper and lower lip. This finding is due to the fact that the measurement point was different. The amount of incisor show, Stms-Is(pFH) was 2-3mm in both boys and girls and did not change according to age. This finding was similar to that of Burstone's[5] which was 3-4mm in adolescent, 2.5-4mm in adult. The interlabial gap, Stms-Stmi did not show consistent findings according to the age because it was hard to standardize the lip posture during X-ray taking especially in the young child. There should be proper methodology for taking rest lip position. As the sample was normal, Sn-Ls(deg to FH), Li-Si(deg to FH), Sn- Pg′(deg to FH)remained unchanged.

3. Nose

The absolute length of nose base, Pn-Sn(FH) increased with age while the angular measurement, Sn-N′-Pn(deg) remained relatively constant. This is due to forward and downward growth of the nose and there were no differences between boys and girls. Posen[25], Chaconas[9] reported in their research on nose that the nose grows downward and forward, and boys mature earlier than girls. As the sample consists of 3 to 12 years of age, it was not possible to observe the difference of maturity between boys and girls due to growth peak difference.

4. Thickness

The Lip plays a very important role in pre and post treatment. evaluation of profile. Its relative position as well as thickness play important role as stated by Burstone[6]. In this study, A-Sn(FH) increased with age in both boys and girls but with greater incremental rate in boys. Probably it was due to the fact that facial convexity increase a little in boys. Burstone[5]reported in his study that (18.7mm in adolescent boys, 16.9 mm in adolescent girls, and 19.3mm in adult male, 15.5mm in adult female.) While in this study, 14mm in boys and 13.5mm in girls were obtained. This results from the fact that the age of Burstone's sample was higher than that of this study. Lee[43] reported that the posterior dimension of the upper lip were 10.76mm in boys, 10.07 mm in girls, and the posterior dimension of the lower lip were 13.95mm in boys and 13.19 mm in girls at 10.3 years of age. At 16 years of age, posterior dimension of the upper lip in boys was 17.81 mm, 15.18mm in girls and posterior dimension of lower lip was 16mm in boys and 14.64mm in girls. In this study, at the age of 8 years, posterior dimension of the upper lip were 13.17mm and 12.27mm in boys and girls respectively, and posterior dimension of upper and lower lip increased with age. The thickness of Pogonion area did not change much with age in this study, and it is consistent with Burstone's[5] result that it change less than other parts of the craniofacial complex. The analysis of soft tissue plays a great role in establishing

treatment plan as stated in many articles. It does not have, however, any correlation with hard tissue. Separate analysis and many other measurements are required. In previous study, many analysis of the soft tissue of Korean children have been reported, however, longitudinal study has not been performed. We hope this study to be helpful for further research on soft tissue.

V Summary

Today's orthodontic treatment goals lie in functional esthetics, and the importance of the latter is increasing gradually in trend. Considering such, study on growth and development of hard as well as soft tissues becomes inevitable. Early studies emphasize mainly on skeletal analysis using cephalometric data. However, more recent studies report that maxillofacial soft tissue, which plays a critical role in determining facial esthetics, is influenced by underlying hard tissue, and yet close relationship between them was not noticed.

Cephalometric x-rays were taken of 137 Korean boys and 106 girls with no systemic disease, fair developmental status and normal occlusion for 2 consecutive years; afterwards, soft tissue analysis, which was divided into four parts, facial form, lip position & posture, nose, and thickness, was done to correlate them with general growth.

The following conclusions were obtained:

1. Facial Form
   Facial convexity in boys showed slight increase; this seems to be associated with greater increase rate of A-Sn in boys. Also, lower facial structures showed more growth compared to the upper ones.
2. Lip Position & Posture
   Nasolabial angle showed little change with aging. The mean value for boys was 93.11° and for girls, 97.56. These were more acute compared to the mean value of 102° in caucasian. Little change was observed in lip prominence to esthetic line. Boys showed greater lip prominence than girls. This fact could be taken into consideration when deciding extraction.
   The amount of exposure of upper incisors was 2-3mm in both boys and girls.
3. Nose
   Absolute length of nose base increases with growth, whereas Sn-N'-Pn showed little increase with aging. This is because the nose grows in antero-inferior direction.
4. Thickness
   A-Sn increased with aging in both boys and girls; that of boys showed greater amount of change. There was an increase in thickness of upper and lower lips with aging, but not in that of soft tissue pogonion.
   This agrees with the results of other earlier studies.

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국문요약

3-11세 아동의 두개 및 연조직의 성장변화에 관한 준종단적 연구

연세대학교 치과대학 교정학 교실

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현대 교정의 치료 목표는 기능 교합과 안모의 심미성에 있다고 하겠으나 이중 심미적 외모에 대한 중요성은 시대의 흐름에 따라 점차 증가하고 있다. 이런 상황에서 경조직과 연조직의 성장과 발육에 대한 지식은 필수적이라 하겠다. 이전의 연구는 주로 두부방사선적 연구를 통한 골격적 분석에 치중하여 왔다. 하지만 안모의 심미성에 관해 중요한 역할을 하는 악안면 연조직은 하부경조직의 영향을 받지만 긴밀한 연관 관계를 구하기는 어렵다는 연구들이 근래에 보고되었다. 이에 본 저자는 성장기 한국인 3-11세 아동 중에 전신 질환이 없고 발육 상태가 양호하며 교합 상태가 정상인 남자 137명과 여자 106명을 대상으로 만 2년간 두부 방사선 사진을 채득하여 연조직의 분석을 facial form, lip position & posture, Nose, Thickness의 4 부분으로 나누어 성장과의 관계를 연구한바 다음과 같은 결론을 얻었기에 보고하는 바이다.

1. Facial Form
   Facial convexity가 남자 아동에 있어서 약간의 증가량을 보였는데 이는 A-Sn 의 증가율이 남자 아동에서 큰 것과 관련이 있는 듯하다. 또한 안면 하방 구조가 시간이 지남에 따라 상방 구조보다 더 많은 성장이 일어났다.
2. Lip position and posture
   Nasolabial angle은 연령에 따라 큰 변화가 없는 것으로 보이며 이 평균값은 남자 93.11, 여자 97.56으로 서양인의 102보다는 예각을 보였으며 Esthetic line에 대한 돌출도는 대체로 큰 변화가 없었다. 남자 아동이 여자 아동보다 입술의 돌출도가 더 큰 값을 보였는데 이는 심미적 이유로 발치를 고려할 때 차이를 보일 수 있는 결과라고 하겠다. 상악 전치의 노출도는 남녀 공히 2-3mm의 값을 보였다.
3. Nose
   비저의 절대적 길이는 성장에 따라 증가하는데 비해 Sn-N'-Pn은 연령 증가의 변화가 없었는데 이는 코의 성장이 전하방으로 이루어지기 때문이다.
4. Thickness
   A-Sn의 길이는 남녀 아동에 있어서 연령에 따라 증가하였는데 그중 남자 아동에 있어서 변화폭이 컸다. 상순 후경과 하순 후경 역시 연령에 따라 증가하였으나 Pogonion의 연조직 두께는 큰 차이를 보이지 않았는데 이는 다른 연구 결과와 유사한 결과이다.

주요 단어 : 삽입하여 주세요